

In the Claims

1. (Withdrawn) A method to prepare a porous cross-linked metal oxide or silicon oxide based aerogel material, the method comprising:

(a) first, forming a metal oxide or silicon oxide based sol-gel material to provide a preformed metal oxide or silicon oxide based sol-gel material; then,

(b) contacting the preformed metal oxide or silicon oxide based sol-gel material with a cross-linking agent, the cross-linking agent comprising an organic compound, to provide a cross-linked metal oxide or silicon oxide based sol-gel material comprising organic cross-links; and then,

(c) drying the cross-linked metal oxide or silicon oxide based sol-gel material to form the porous cross-linked metal oxide or silicon oxide based aerogel material.

2. (Withdrawn) The method of claim 1, wherein the cross-linking agent is an isocyanate.

3. (Withdrawn) The method of claim 1, wherein the cross-linking agent comprises a diisocyanate, an acid anhydride, an acylchloride, a bis(acid anhydride), or a bis(acylchloride).

4. (Withdrawn) The method of claim 1, wherein the cross-linking agent comprises an attached group.

5. (Withdrawn) The method of claim 4, wherein the attached group is an absorbant, a catalyst, a fluorophore, a biomolecule, a redox active label, or a reactive group.

6. (Cancelled)

7. (Withdrawn) The method of claim 1 wherein the cross-linked metal oxide or silicon oxide based aerogel material is a cross-linked silica-based aerogel material.
8. (Withdrawn) The method of claim 1, wherein the sol-gel material is substantially filled with a solvent.
9. (Withdrawn) The method of claim 8, wherein the solvent is selected from the group consisting of water, ketones, alcohols, esters, carbonates, lactones, hydrocarbons, and mixtures thereof.
10. (Withdrawn) The method of claim 9, wherein the alcohol is methanol or ethanol.
11. (Withdrawn) The method of claim 9, wherein the ketone is acetone.
12. (Withdrawn) The method of claim 9, wherein the solvent is propylene carbonate, ethyl acetate, or butyrolactone.
13. (Withdrawn) The method of claim 1, wherein the metal oxide or silicon oxide based sol-gel material is a silica-based sol-gel material.
14. (Withdrawn) The method of claim 13, wherein the silica-based sol-gel material is prepared from silicon alkoxides via an acid or a base-catalyzed route.
15. (Withdrawn) The method of claim 1, wherein the cross-linking agent is in a solvent.
16. (Withdrawn) The method of claim 15, wherein the solvent is selected from the group consisting of water, alcohols, ketones, esters, carbonates, lactones, and mixtures thereof.
17. (Withdrawn) The method of claim 16, wherein the alcohol is methanol or ethanol.

18. (Withdrawn) The method of claim 2, wherein the isocyanate is a monoisocyanate, a diisocyanate, a triisocyanate, a tetraisocyanate, a polyisocyanate, an oligoisocyanate, or a combination thereof.

19. (Withdrawn) The method of claim 2, wherein the isocyanate is hexamethylene diisocyanate, poly(hexamethylene diisocyanate), toluene diisocyanate, diphenylmethane diisocyanate, an aliphatic polyisocyanate, triphenylmethyl triisocyanate, or a mixture thereof.

20. (Withdrawn) The method of claim 1, wherein the cross-linked metal oxide or silicon oxide based sol-gel material is dried supercritically.

21. (Withdrawn) The method of claim 20, wherein the cross-linked metal oxide or silicon oxide based sol-gel material is dried with liquid carbon dioxide.

22. (Withdrawn) The method of claim 1, wherein the drying is conducted at ambient pressure.

23. (Previously Presented) A porous cross-linked metal oxide or silicon oxide based aerogel material produced by:

(a) first, forming a metal oxide or silicon oxide based sol-gel material to provide a preformed metal oxide or silicon oxide based sol-gel material; then,

(b) contacting the preformed metal oxide or silicon oxide based sol-gel material with a cross-linking agent, the cross-linking agent comprising an organic compound, to provide a cross-linked metal oxide or silicon oxide based sol-gel material comprising organic cross-links; and then,

(c) drying the cross-linked metal oxide or silicon oxide based sol-gel material to form the porous cross-linked metal oxide or silicon oxide based aerogel material.

24. (Cancelled).

25. (Previously Presented) A cross-linked metal oxide or silicon oxide based sol-gel material, wherein a metal oxide or silicon oxide based sol-gel material is formed to provide a preformed metal oxide or silicon oxide based sol-gel material, then a cross-linking agent comprising an organic compound is deposited on surfaces of the preformed metal oxide or silicon oxide based sol-gel material so as to form a cross-linked metal oxide or silicon oxide based sol-gel material comprising organic cross-links.

26. (Previously Presented) The cross-linked metal oxide or silicon oxide based sol-gel material of claim 25, wherein the cross-linking agent comprises at least about 2% by weight of the cross-linked metal oxide or silicon oxide based sol-gel material.

27. (Previously Presented) The cross-linked metal oxide or silicon oxide based sol-gel material of claim 25, wherein the cross-linking agent comprises at least about 5% by weight of the cross-linked metal oxide or silicon oxide based sol-gel material.

28. (Previously Presented) The cross-linked metal oxide or silicon oxide based sol-gel material of claim 25, wherein the cross-linking agent comprises at least about 10% by weight of the cross-linked metal oxide or silicon oxide based sol-gel material.

29. (Previously Presented) The cross-linked metal oxide or silicon oxide based sol-gel material of claim 25, wherein the cross-linking agent comprises at least about 30% by weight of the cross-linked metal oxide or silicon oxide based sol-gel material.

30. (Previously Presented) The cross-linked metal oxide or silicon oxide based sol-gel material of claim 25, wherein the cross-linking agent comprises at least about 50% by weight of the cross-linked metal oxide or silicon oxide based sol-gel material.

31. (Previously Presented) The cross-linked metal oxide or silicon oxide based sol-gel material of claim 25, wherein the cross-linking agent comprises at least about 80% by weight of the cross-linked metal oxide or silicon oxide based sol-gel material.

32. - 35. (Cancelled)

36. (Currently Amended) The sol-gel material of claim 25, wherein the preformed metal oxide or silicon oxide based sol-gel material is silica based.

37. (Previously Presented) The cross-linked metal oxide or silicon oxide based sol-gel material of claim 25, wherein the cross-linking agent is a diisocyanate, a triisocyanate, a polyisocyanate, or a mixture thereof.

38. (Previously Presented) The cross-linked metal oxide or silicon oxide based sol-gel material of claim 25, wherein the cross-linking agent is hexamethylene diisocyanate, poly(hexamethylene diisocyanate), toluene diisocyanate, diphenylmethane diisocyanate, an aliphatic polyisocyanate, triphenylmethyl triisocyanate, or a mixture thereof.

39. (Previously Presented) The cross-linked metal oxide or silicon oxide based sol-gel material of claim 25, wherein the cross-linked metal oxide or silicon oxide based sol-gel material is more resistant to rupture under load than the preformed metal oxide or silicon oxide based sol-gel material prior to cross-linking with the cross-linking agent.

40. (Previously Presented) A cross-linked metal oxide or silicon oxide based aerogel material formed by drying of the cross-linked metal oxide or silicon oxide based sol-gel material

of claim 25, the drying being carried out using solvent exchange or supercritical drying, or both, such that the aerogel material does not collapse when in contact with a liquid that comprises water, an alcohol, an ether, a hydrocarbon, an ester, a ketone, a carboxylic acid, a phosphoric acid, or a liquefied gas.

41. (Previously Presented) The cross-linked metal oxide or silicon oxide based aerogel material of claim 40, wherein the liquefied gas is nitrogen, argon, helium, hydrogen, or oxygen.

42. (Previously Presented) The cross-linked metal oxide or silicon oxide based aerogel material of claim 40, wherein the hydrocarbon is kerosene, gasoline, jet fuel, or rocket fuel.

43. (Withdrawn) A method to link an attached group to a cross-linked metal oxide or silicon oxide based sol-gel material comprising the method of claim 1 wherein the cross-linking agent comprising an organic compound that includes the attached group.

44. (Withdrawn) A capacitor comprising the material of claim 23.

45. (Withdrawn) A dielectric comprising the material of claim 23.

46. (Withdrawn) An electrical circuit comprising the material of claim 23.

47. (Previously Presented) A thermal insulating material comprising the sol-gel material of claim 25.

48. (Original) A tile, door, panel, shingle, shutter, beam, cooler, article of clothing, shoe, or boot comprising the thermal insulating material according to claim 47.

49. (Previously Presented) A structural material comprising the material of claim 25.

50. (Withdrawn) A method to dry the cross-linked metal oxide or silicon oxide based sol-gel material of claim 1 comprising:

a) washing the cross-linked metal oxide or silicon oxide based sol-gel material, wherein the cross-linked metal oxide or silicon oxide based sol-gel material is filled with a solvent, with a new solvent to exchange the solvent of the cross-linked metal oxide or silicon oxide based sol-gel material with the new solvent; and

b) drying the solvent-exchanged cross-linked metal oxide or silicon oxide based sol-gel material under non-supercritical conditions.

51. (Withdrawn) The method of claim 50, wherein the drying is conducted at ambient pressure.

52. (Withdrawn) The method of claim 50, wherein the drying is conducted at a temperature that is at least about 4°C.

53. (Withdrawn) The method of claim 50, wherein the drying is conducted at a temperature that is at least about 20°C.

54. (Withdrawn) The method of claim 50, wherein the drying is conducted at a temperature that is at least about 40°C.

55. (Withdrawn) The method of claim 50, wherein the drying is conducted at a temperature that is at least about 60°C.

56. (Withdrawn) The method of claim 50, wherein the drying is conducted at a temperature that is at least about 80°C.

57. (Withdrawn) The method of claim 50, wherein the drying is conducted at a temperature that is at least about 100°C.

58. (Withdrawn) The method of claim 50, wherein the drying is conducted at a temperature that is at least about 200°C.

59. (Withdrawn) The method of claim 50, wherein the drying is conducted at a temperature that is about or less than 300°C.

60. (Withdrawn) The method of claim 50, wherein the drying is conducted at a temperature of about 40°C.

61. (Withdrawn) The method of claim 50, wherein the drying is by freeze-drying.

62. (Withdrawn) The method of claim 50, wherein the new solvent is an organic solvent.

63. (Withdrawn) The method of claim 62, wherein the organic solvent comprises a (C<sub>1</sub>-C<sub>20</sub>)alcohol, a (C<sub>1</sub>-C<sub>20</sub>)alkane, a (C<sub>3</sub>-C<sub>20</sub>)cycloalkane, a (C<sub>2</sub>-C<sub>20</sub>)alkene, a (C<sub>3</sub>-C<sub>20</sub>)cycloalkene, a (C<sub>2</sub>-C<sub>20</sub>)alkyne, an aryl, a (C<sub>1</sub>-C<sub>20</sub>) alkane substituted aryl, a (C<sub>2</sub>-C<sub>20</sub>)alkene substituted aryl, or a (C<sub>2</sub>-C<sub>20</sub>)alkyne substituted aryl.

64. (Withdrawn) The method of claim 62, wherein the organic solvent is a (C<sub>5</sub>-C<sub>10</sub>)alkane.

65. (Cancelled).

66. (Withdrawn) The method of claim 1 wherein chemical functionality of surfaces of said metal oxide or silicon oxide based sol-gel material acts as a template for reaction with the cross-linking agent.

67. (Withdrawn) The method of claim 1 wherein surfaces of the metal oxide or silicon oxide based sol-gel material act as a template for the cross-linking agent.

68. (Cancelled).

69. (Previously Presented) The metal oxide or silicon oxide based sol-gel material of claim 25 wherein a chemical functionality of the surfaces of said metal oxide or silicon oxide based sol-gel material acts as a template for reaction with, accumulation of, or both, the cross-linking agent.

70. (Previously Presented) The metal oxide or silicon oxide based sol-gel material of claim 25 wherein the surfaces of the metal oxide or silicon oxide based sol-gel material act as a template for the cross-linking agent.

71. (Previously Presented) The sol-gel material of claim 25 comprising an attached group wherein the cross-linking agent comprising an organic compound includes the attached group.